nPDF @ EIC

S. Fazio

Update

EIC Task Force meeting

BNL – Sep. 15th, 2016

F2

In order to calculate F2, from just the reduced cross section we use the formula:

F2 = sigma_red*(1+(1-y) ^{2})/(2*[1-y-$Q^2/4E^2$ + (y^2+(Q^2/E^2))/(2[1+R1998])])

where R1998 is a parameterization.

In order to calculate R, we need the take the average of the 3 following equations:

R1 = Theta(x,Q^2)*a1/log(Q^2/0.04) + [1 + a4*x + a5*x^2]x^{a6}*a2/4th-root(Q^2 + $a3^4$)

R2 = Theta(x,Q^2)*b1/log(Q^2/0.04) + [1 + b4*x + b5*x^3]x^b6*[b2/Q^2 + b3/(Q^4+0.3^2)]

R3 = Theta(x,Q^2)*c1/log(Q^2/0.04) + c2*[(Q^2 - Q2_thr)^2 + $c3^2$]$^{-0.5}$

where:

Q2_thr = c4*x + c5*x^2 + c6*x^3

Theta(x,Q^2) = 1 + 12*[Q^2/(Q^2+1)][0.125^2/(0.125^2+x^2)]

a1 = 0.0485; b1 = 0.0481; c1 = 0.0577

a2 = 0.5470; b2 = 0.6114; c2 = 0.4644

a3 = 2.0621; b3 = -0.3509; c3 = 1.8288

a4 = -0.3804; b4 = -0.4611; c4 = 12.3708

a5 = 0.5090; b5 = 0.7172; c5 = -43.1043

a6 = -0.0285; b6 = -0.0317; c6 = 41.7415

Extract the F_L structure function

$$\sigma_r = F_2\left(x,Q^2\right) - \frac{y^2}{1+\left(1-y\right)^2} F_L\left(x,Q^2\right) \qquad \frac{y^2}{1+\left(1-y\right)^2} = Y^+$$

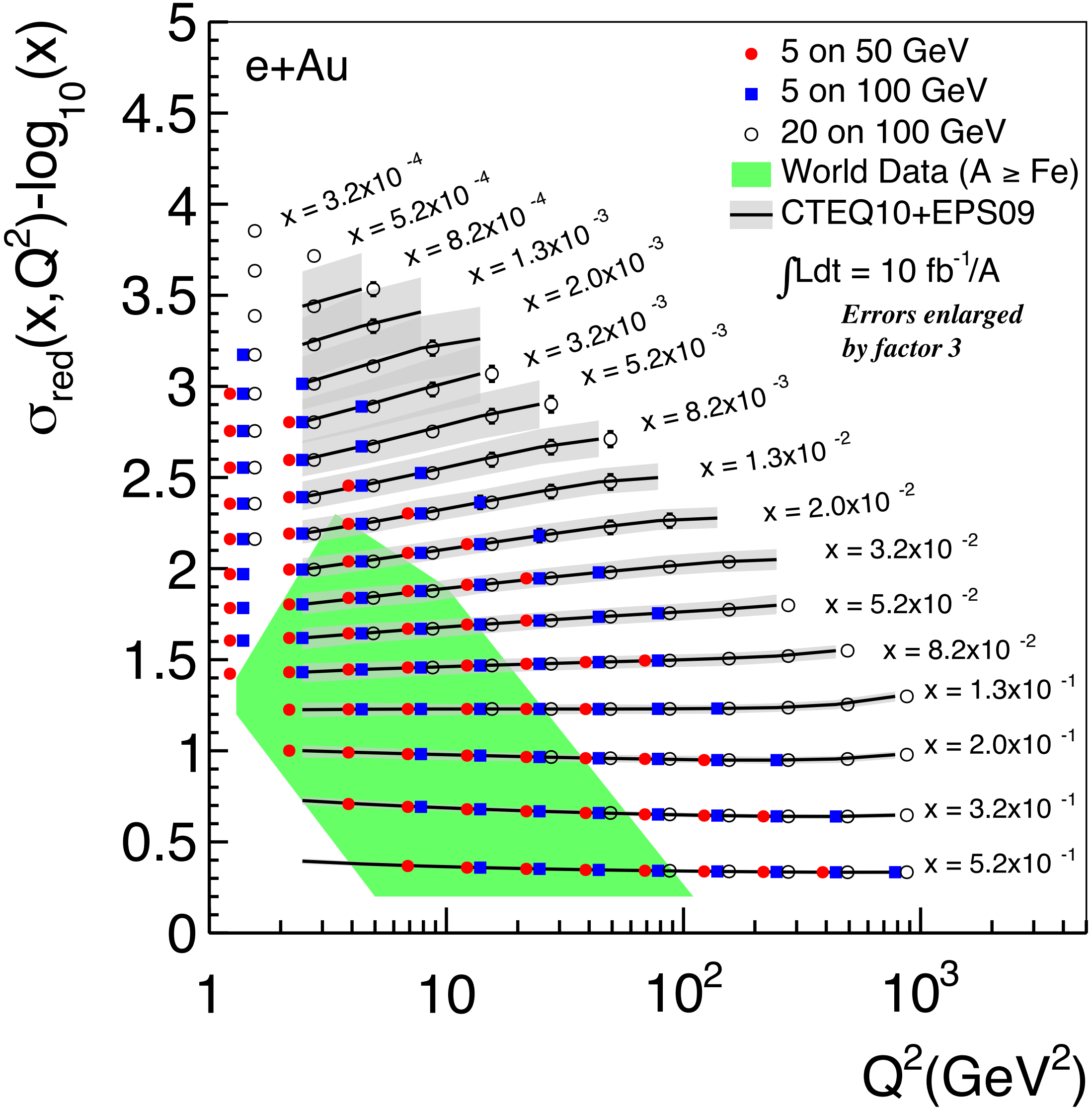
- F_L can be extracted from the reduced xsec using the Rosenbluth technique
- Requires lever arm in Y^+ → (different energies in each x,Q^2 bin)
- We must do this for both the "standard" and the Charmed case
- In calculating the reduced xsec, the statistical and systematic uncertainties must be summed in quadrature → now fixed
- Matt's code for FL extraction not available (the available plot macro has just hard coded values of points on a TGraphError), decided to code my own.

Method:
fit the slops of Y^+ for different √s
at fixed x, Q^2

Simulation:
e+Au sample simulated by Elke using PYTHIA
5(20) x 50 –> L = 2 fb^{-1}/A
5(20) x 75 –> L = 4 fb^{-1}/A
5(20) x 100 –> L = 4 fb^{-1}/A

Total simulated event sample **L = 10 fb^{-1}/A –> ~6 months running** at 50% operational efficiency

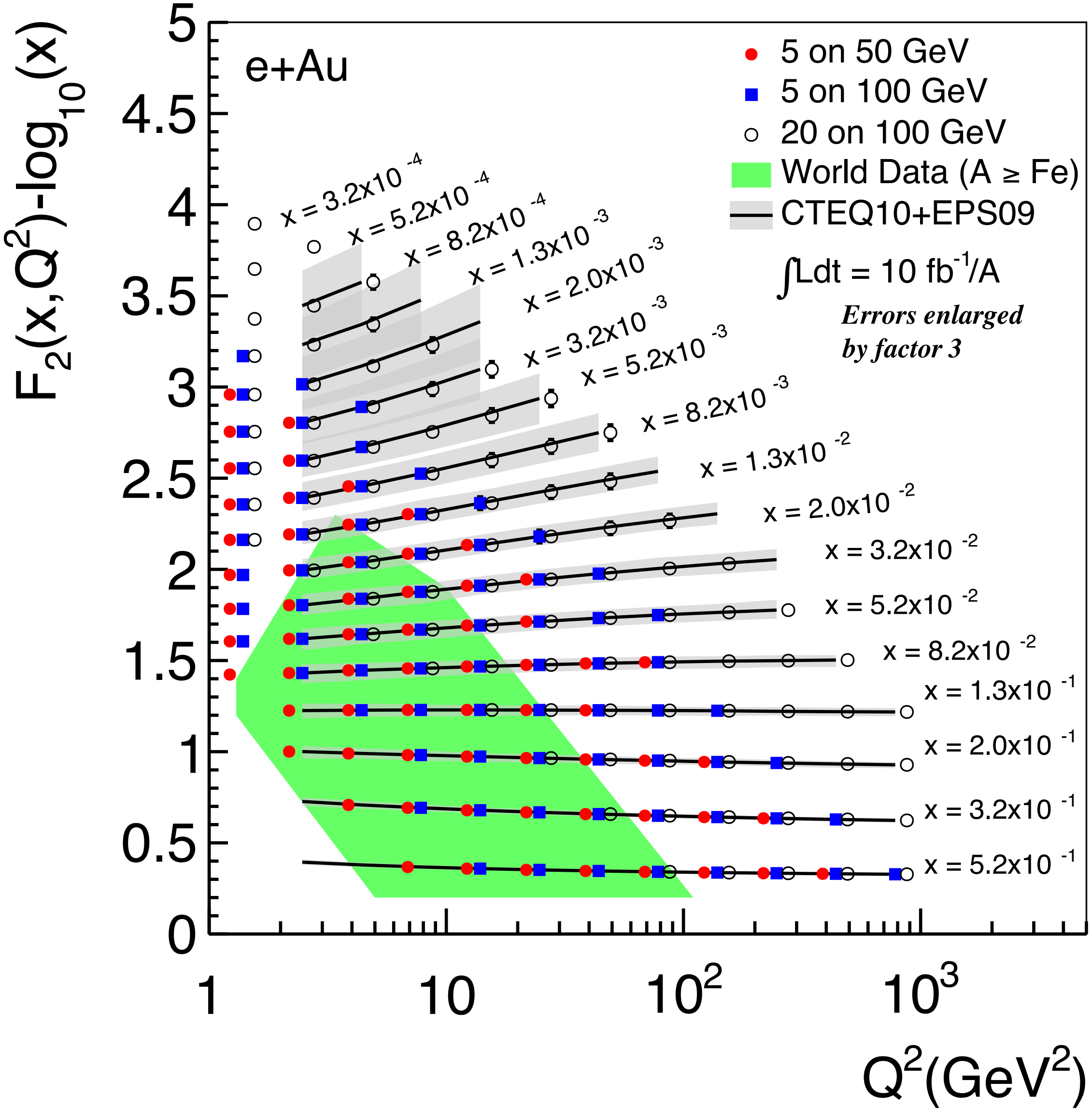
Reduced cross section



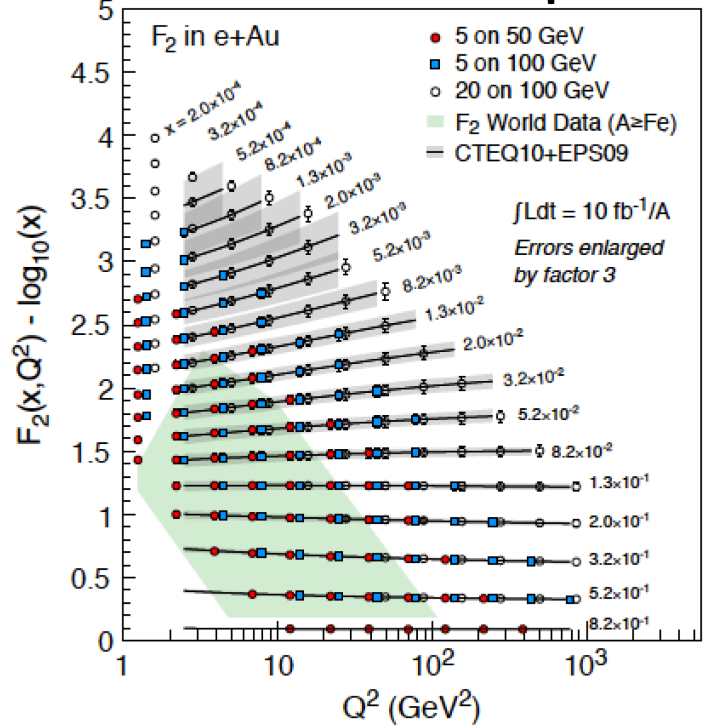
systematics = 3% as in the WP

- Very small quantity compared to Log10(x)
- errors are dominated by the 3% systematics
- errors further enlarged by factor 3 as in the WP

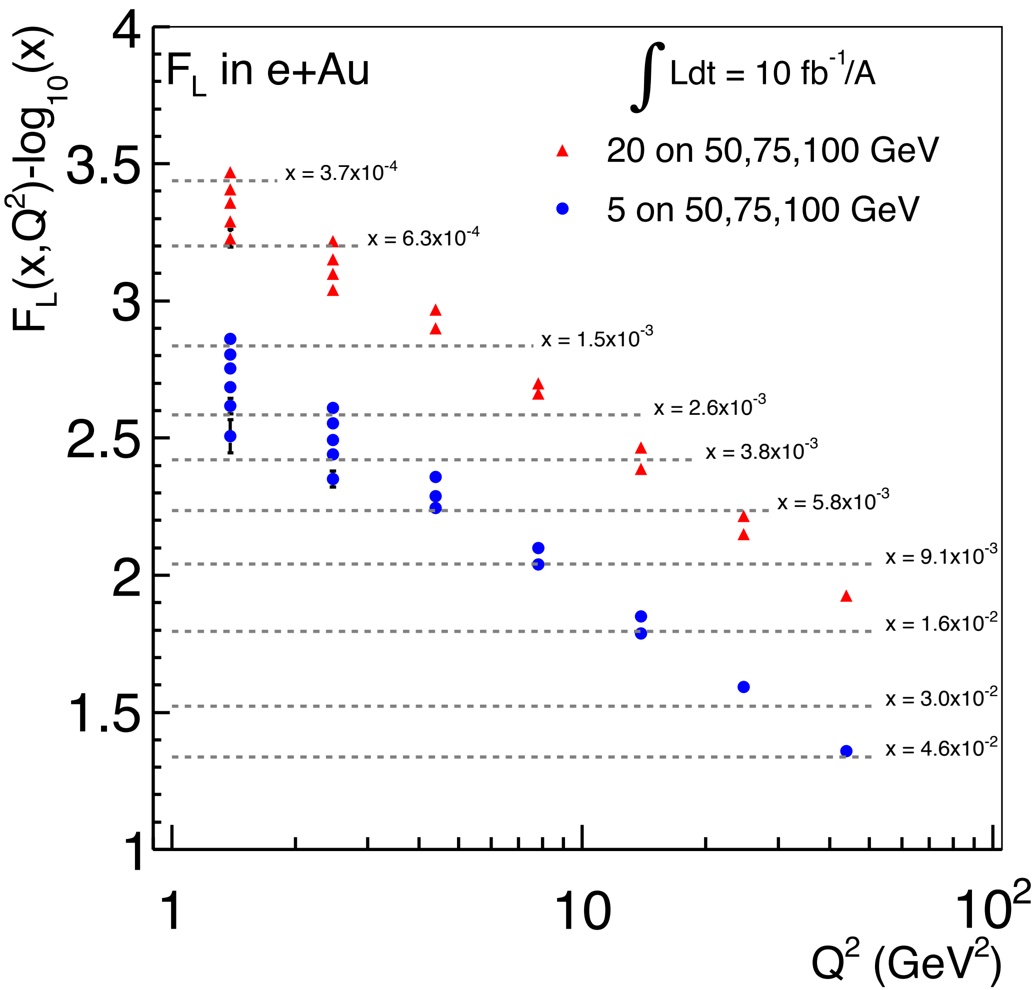
F2 - charm



In the White Paper



F_L in e+Au



These points are where we have

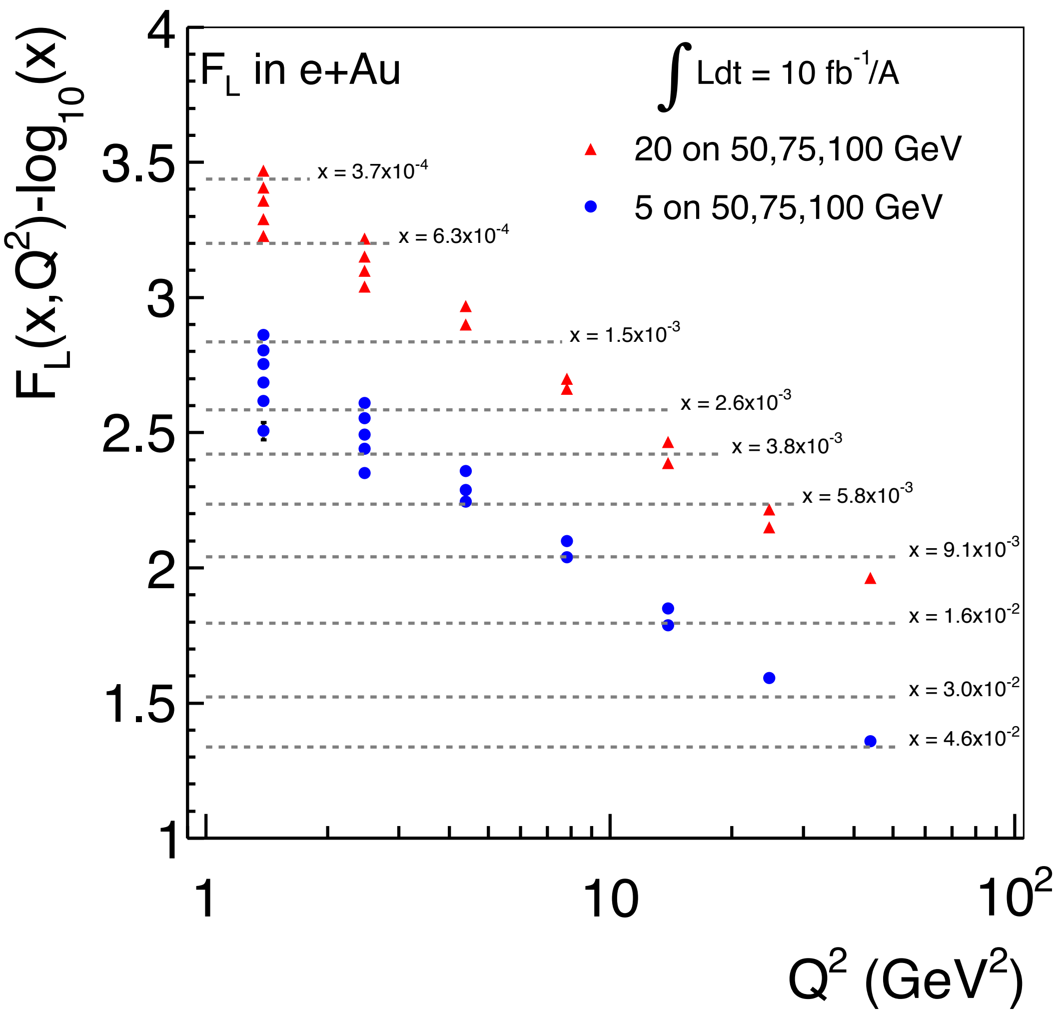
- LEVER ARM (three points, y+ > 0.2)
- Extracted F_L must be one sigma > 0

Physically meaningful measurement

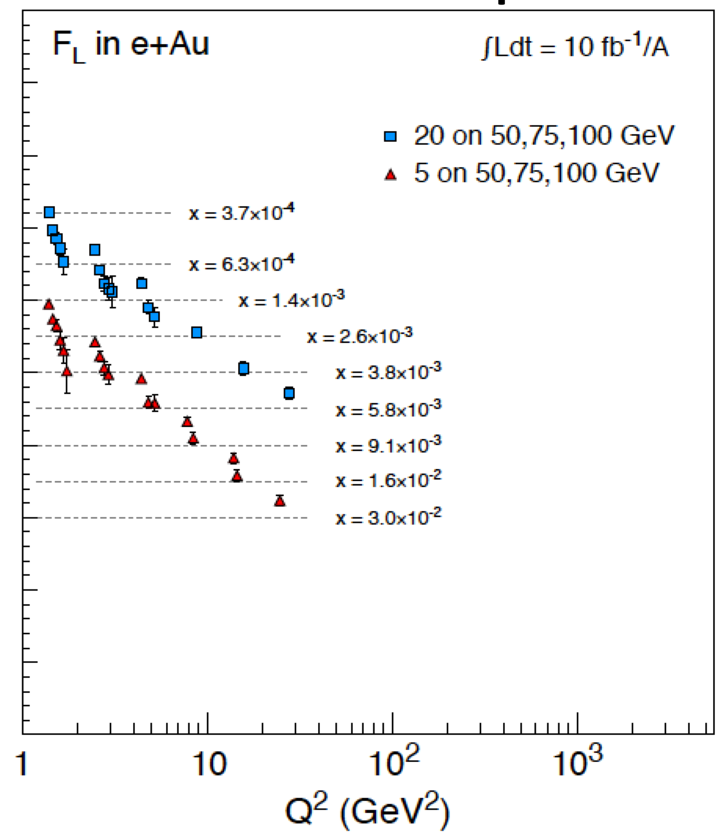
Model dependent!

F_L in e+Au

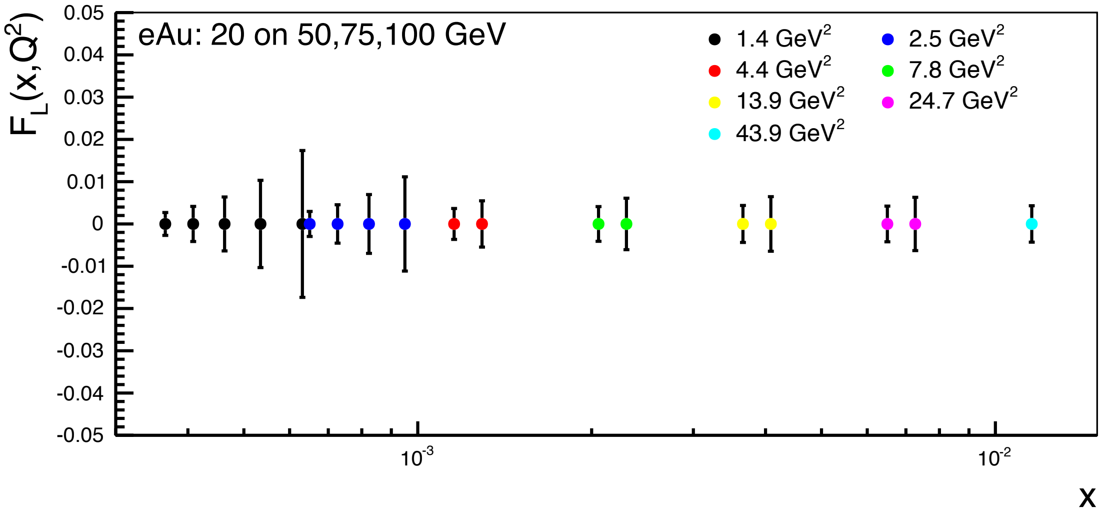
New Plot

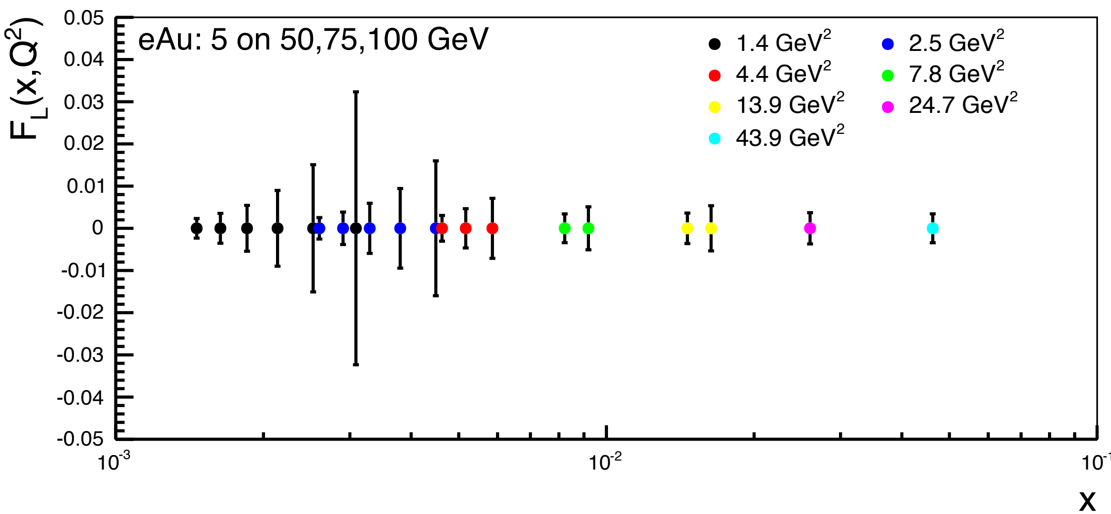


In the White Paper



F_L uncertainties





Charm

Charm selection - Kaons

We look for **kaons** in the final state

0.01 m < |VTX| < 3 m -> Cut on the Decay Vertex

CENTRAL DETECTOR (-1 < Eta < 1):

dE/dx -> 0.2 GeV < P < 0.8 GeV (previous value in Matt's analysis was < 0.5 GeV)

RICH -> 2 GeV < P < 5 GeV (previous value in Matt's analysis was < 15 GeV)

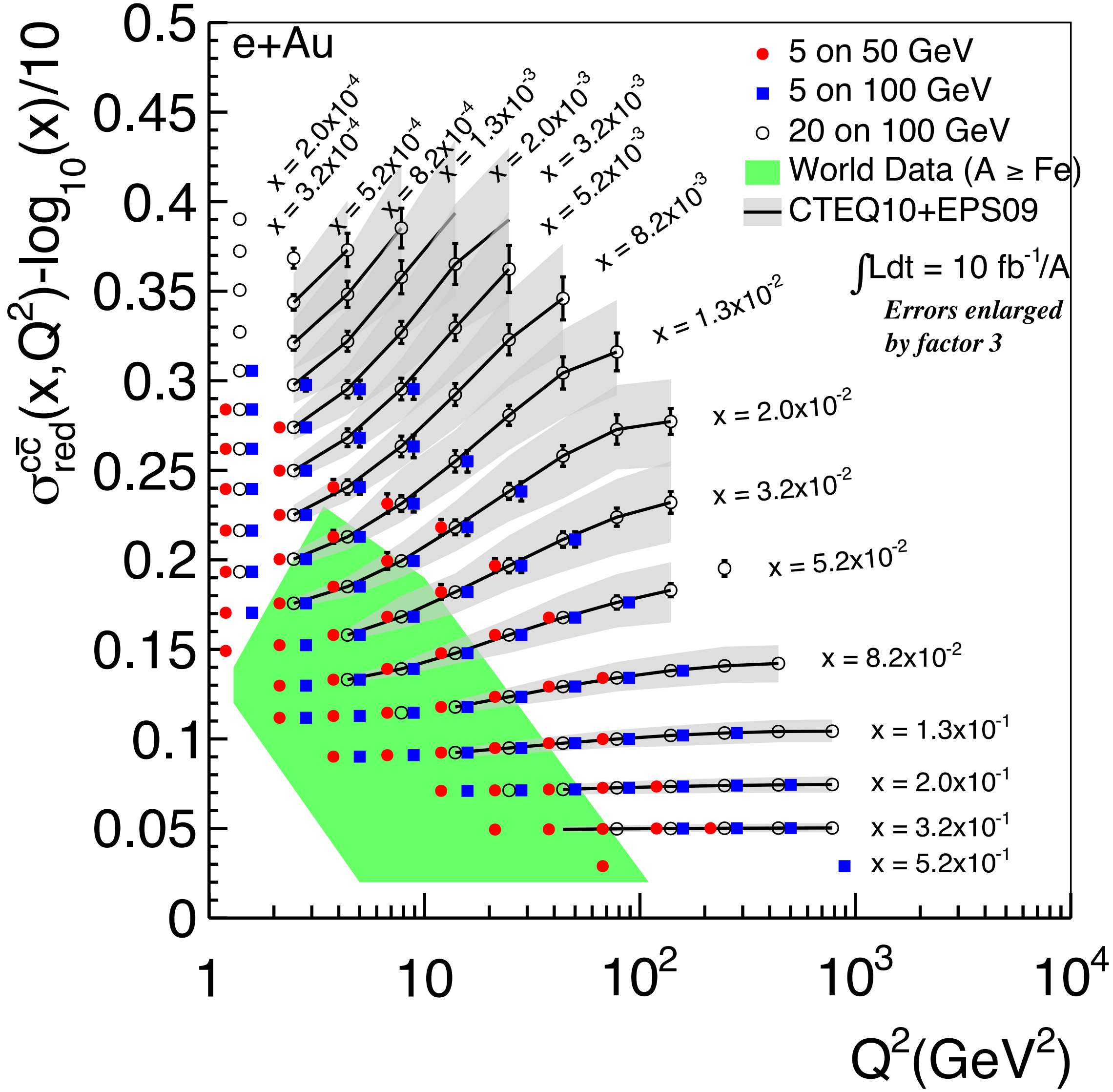
FORWARD (1 < Eta < 3.5):

RICH -> 2 GeV < P < 40 GeV (previous value in Matt's analysis was < 15 GeV)

REAR (-3.5 < Eta < 1):

RICH -> 2 GeV < P < 15 GeV

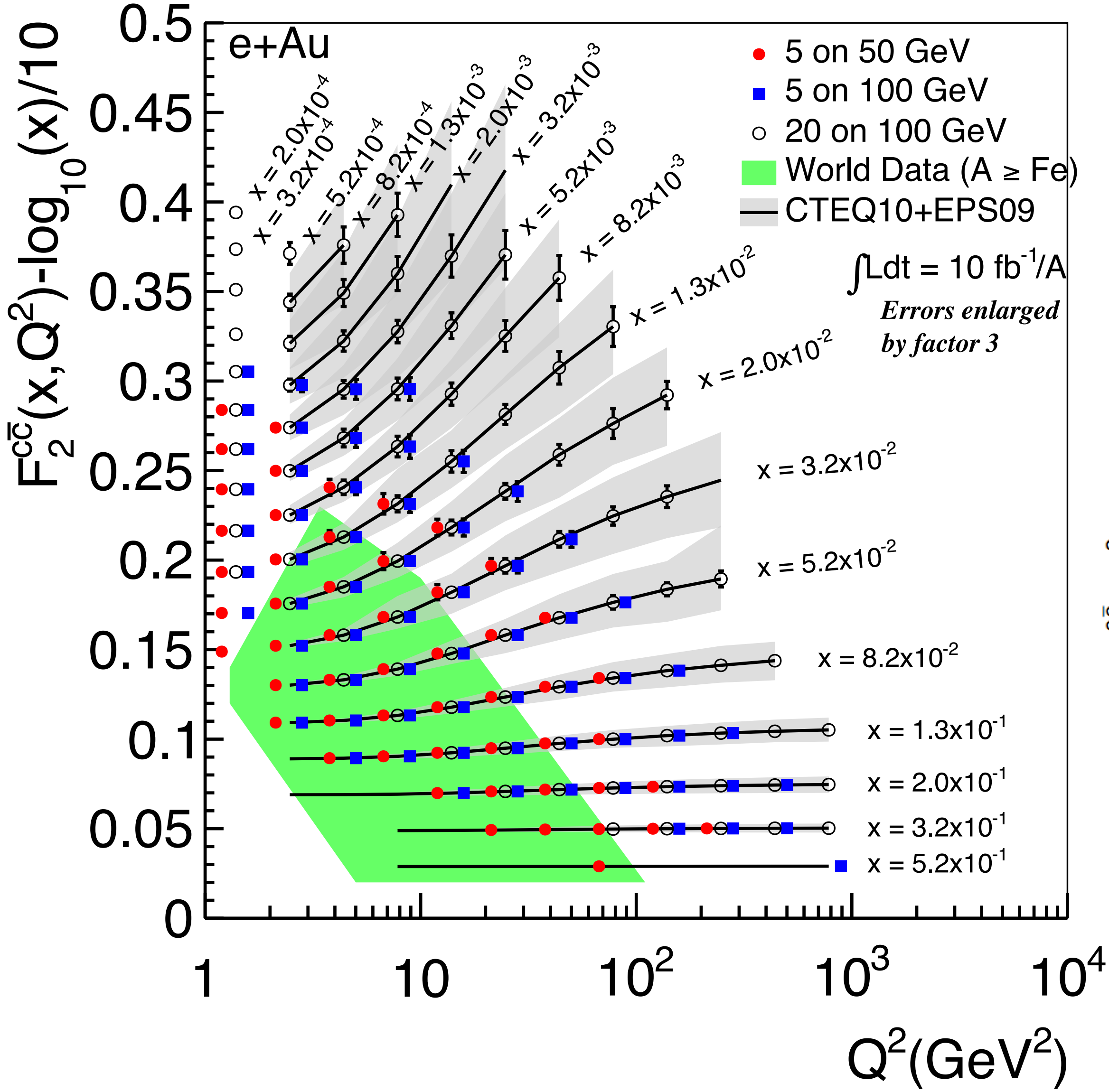
Charm – Reduced cross section



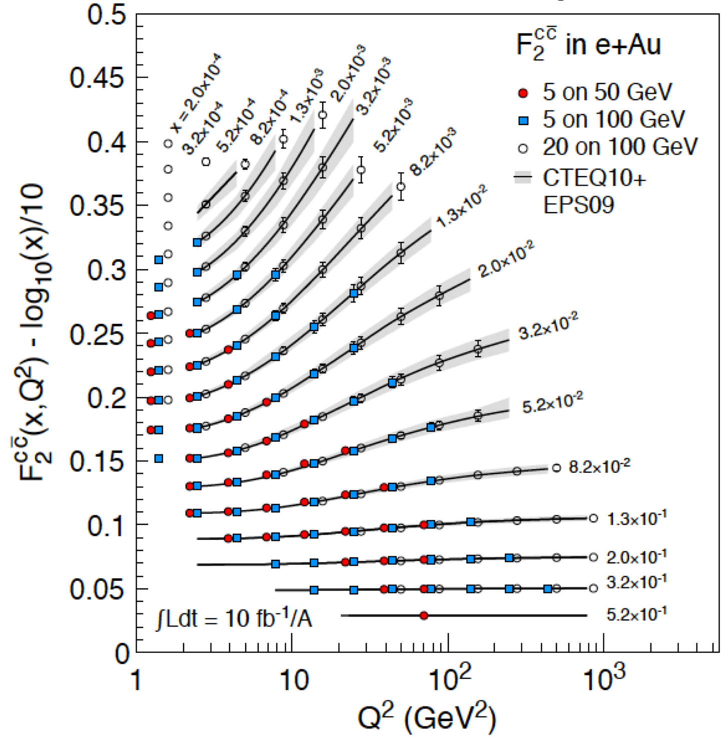
systematics = 7% as in the WP

- Very small quantity compared to Log10(x)/10
- errors are dominated by the 7% systematics
- errors further enlarged by factor 3 as in the WP

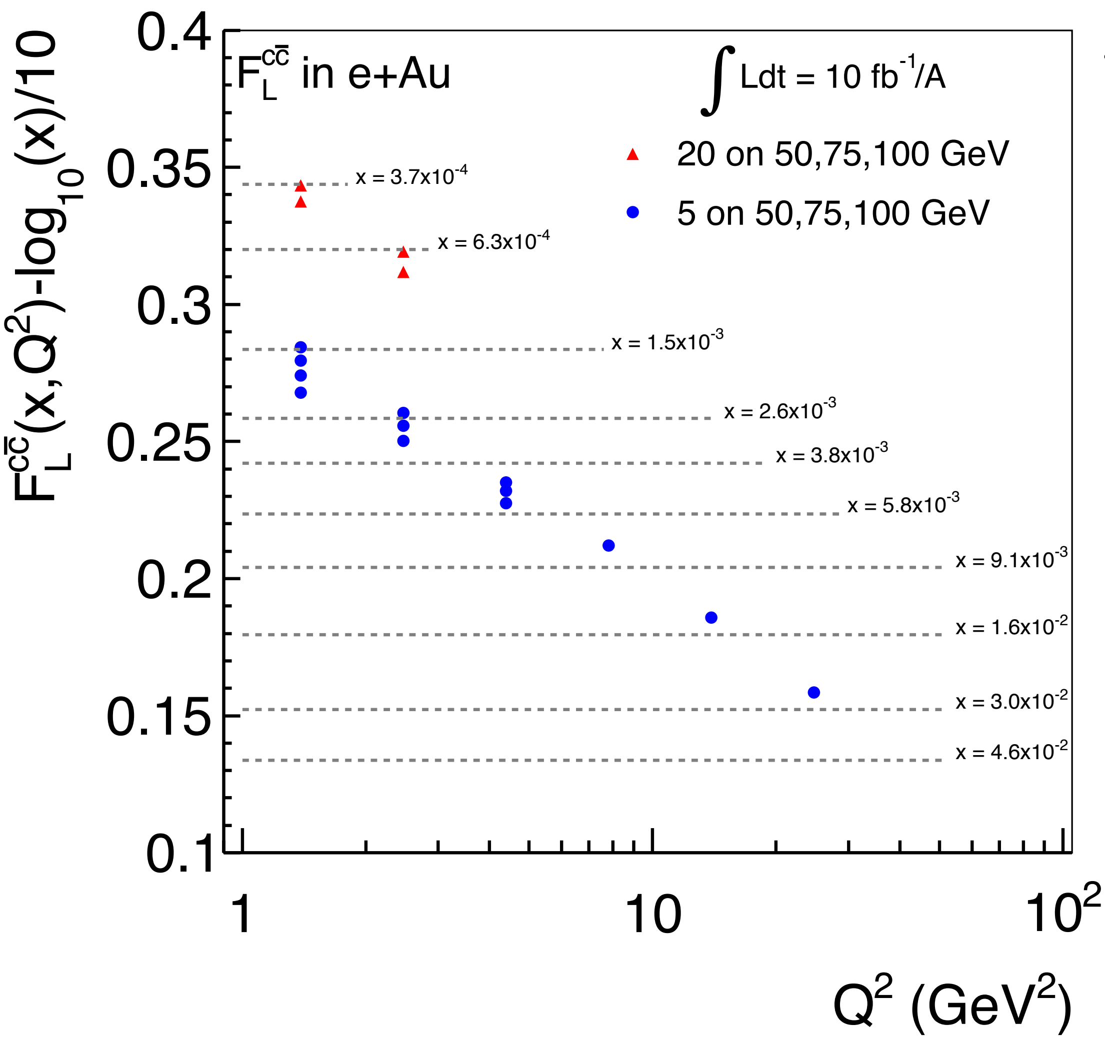
F2 - charm



In the White Paper



F_L^{charm} in e+Au



These points are where we have

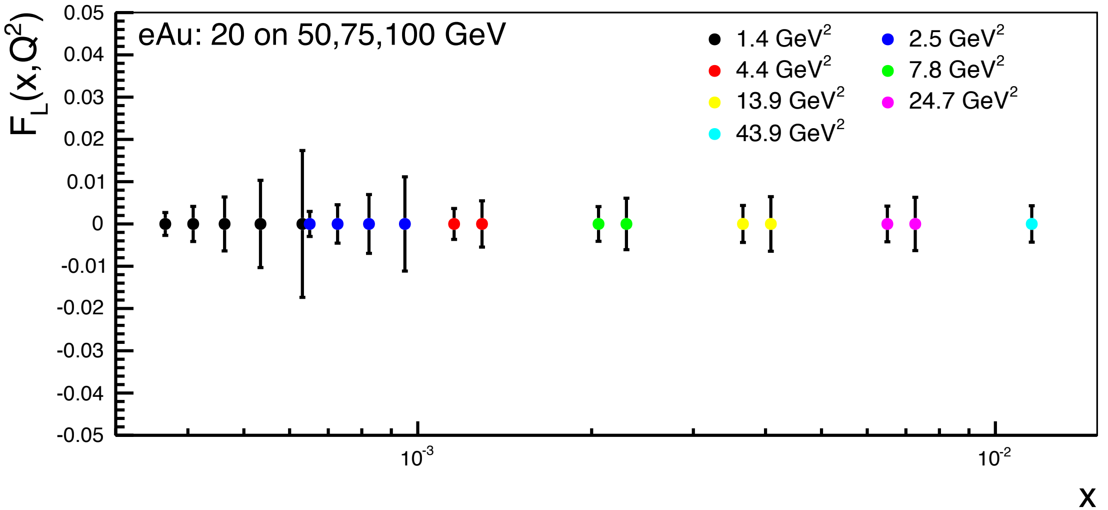
- LEVER ARM (three points, y+ > 0.2)
- Extracted F_L must be one sigma > 0

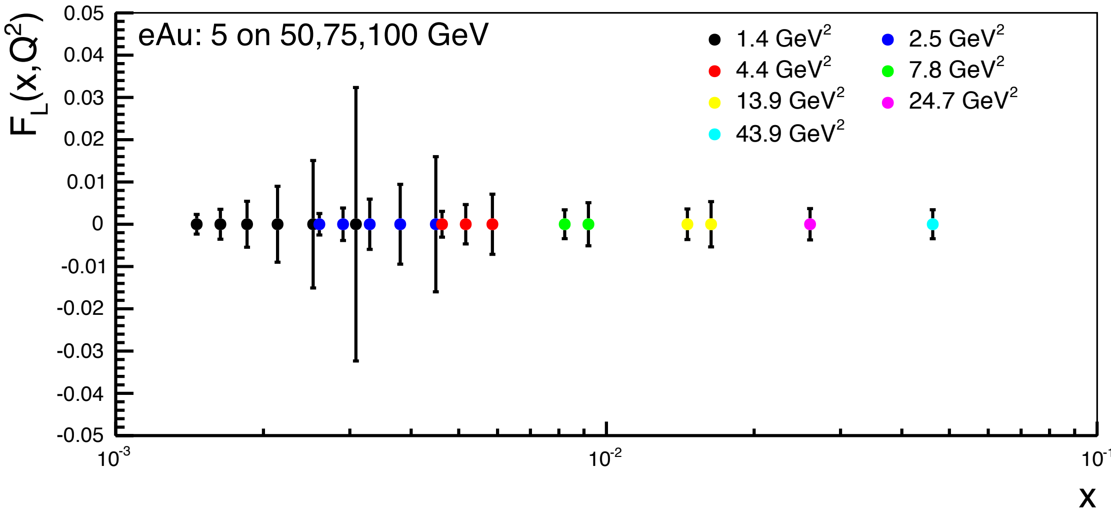
Physically meaningful measurement

Model dependent!

- F_L^{cc} in our simulation is minuscule
- no significant FL for 20 GeV in simulation

F_L-charm uncertainties





Background

We look at background from DIS events with kaons that pass the whole selection but are not coming from a charm decay

We study the fraction of background events over signal as:
Background fraction [Background/Signal] (selected_bkd_events/selected_Charm_Events)

5 GeV x 50 GeV (10M events simulated)
Total number of selected events (charm in acceptance and with a kaon detected): 18822
Total number of background events (in the final selection) = 179
Background fraction [Background/Signal] = 0.95%

5 GeV x 100 GeV (10M events simulated)
Total number of selected events (charm in acceptance and with a kaon detected): 26273
Total number of background events (in the final selection) = 258
Background fraction [Background/Signal] = 0.98%

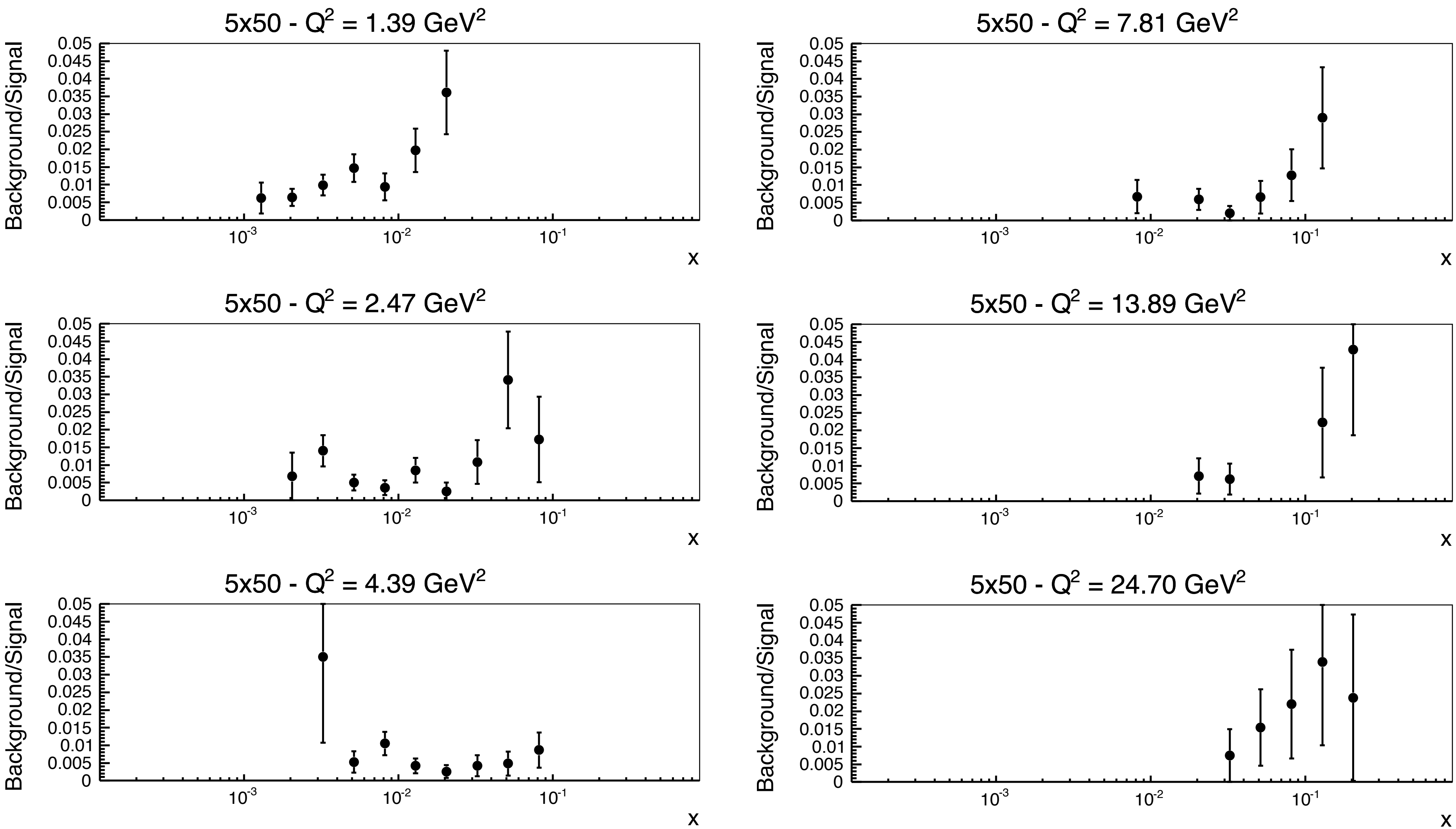
20 GeV x 100 GeV (10M events simulated)
Total number of selected events (charm in acceptance and with a kaon detected): 39624
Total number of background events (in the final selection) = 460
Background fraction [Background/Signal] = 1.16%

Conclusion:
The B/S fraction is expected in the order of ~1% with a slight energy dependence

What about kinematical dependence?

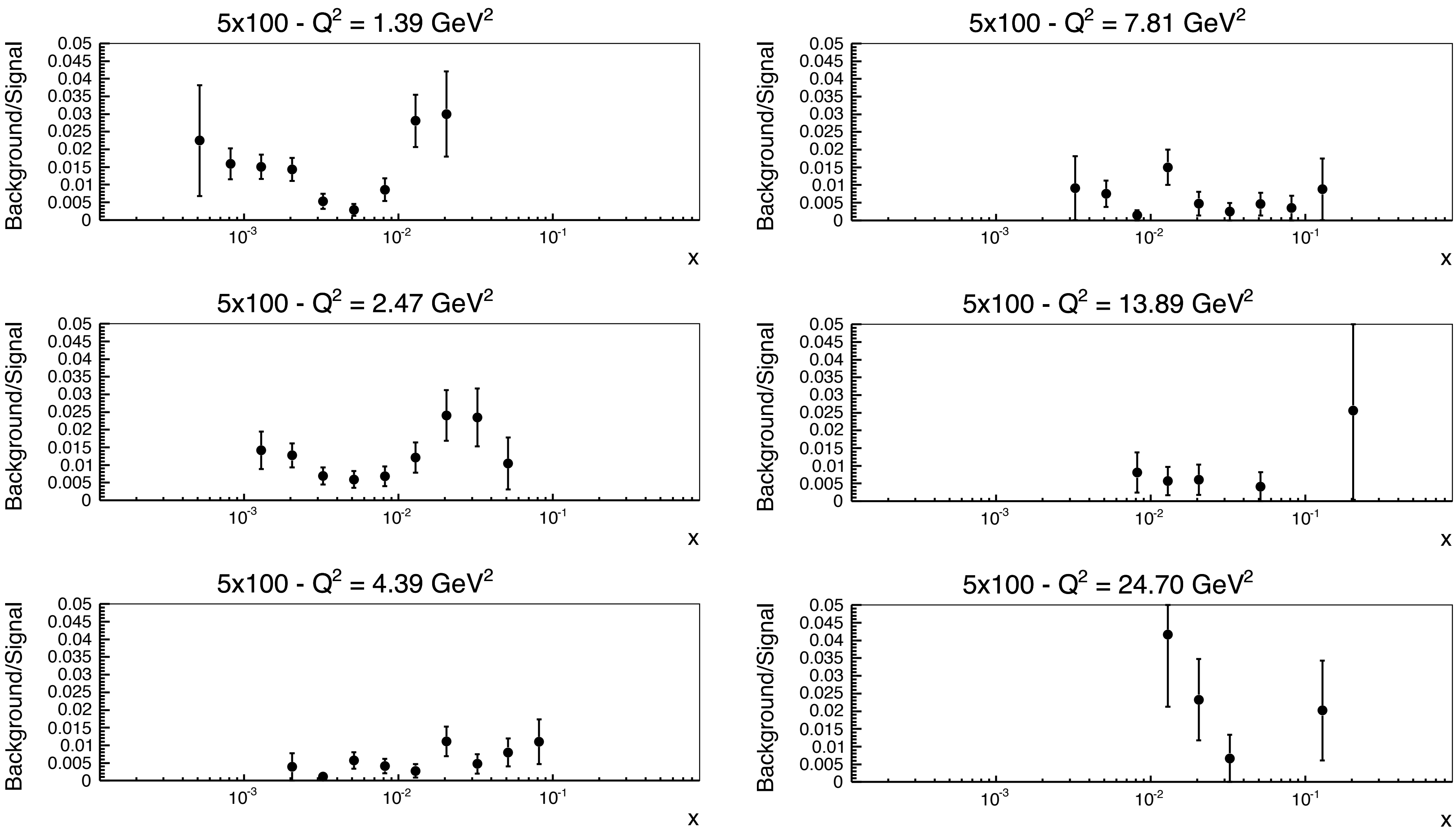
Background – kinematical dependence

The errors on the B/S fraction are calculated with the binomial formula for correlated values



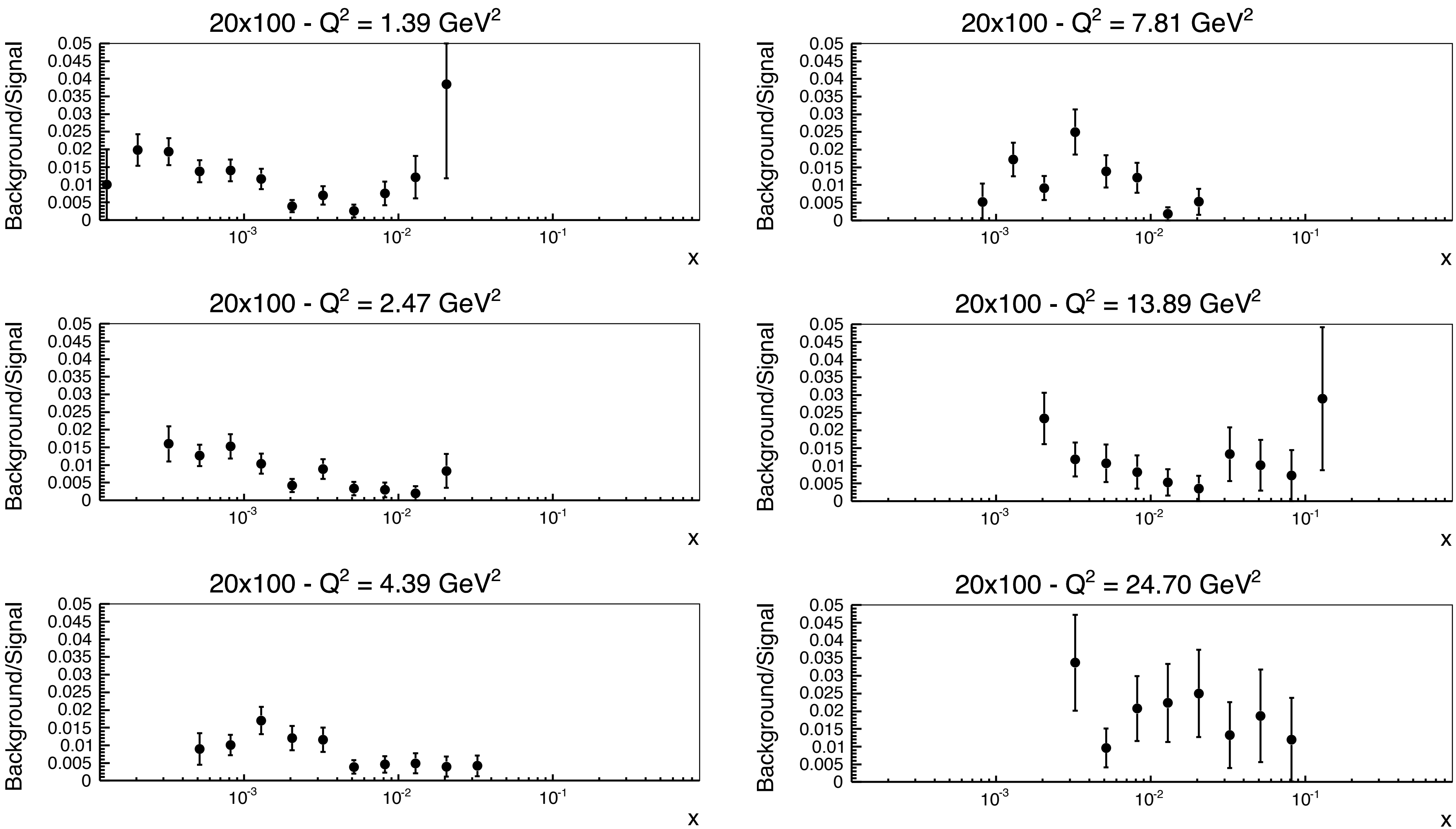
Background – kinematical dependence

The errors on the B/S fraction are calculated with the binomial formula for correlated values



Background – kinematical dependence

The errors on the B/S fraction are calculated with the binomial formula for correlated values



Charm efficiency

We look at the selection efficiency for charm events

We study the charm selection efficiency as:

Charm efficiency = selected_charm_Events / charm_Events_inAcceptance

5 GeV x 50 GeV (10M events simulated)

Total number of selected events (charm in acceptance and with a kaon detected): 18822

Total number of events with a charm in kinematical acceptance: 67544

Charm efficiency = 27.9%

5 GeV x 100 GeV (10M events simulated)

Total number of selected events (charm in acceptance and with a kaon detected): 26273

Total number of events with a charm in kinematical acceptance: 91930

Charm efficiency = 28.6%

20 GeV x 100 GeV (10M events simulated)

Total number of selected events (charm in acceptance and with a kaon detected): 39624

Total number of events with a charm in kinematical acceptance: 138672

Charm efficiency = 28.6%

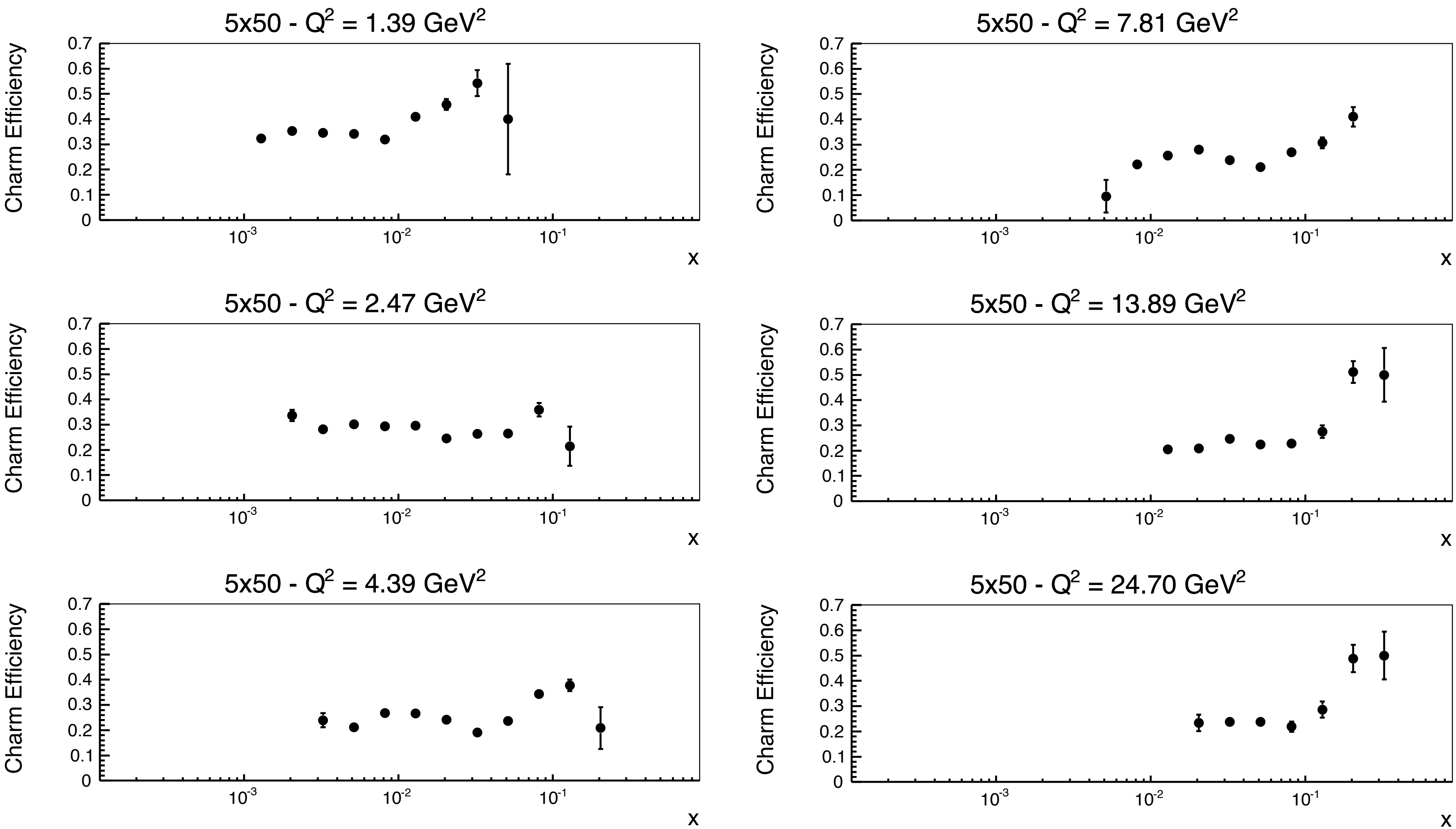
Conclusion:

The charm selection efficiency is expected in the order of ~28% with no significant energy dependence

What about kinematical dependence?

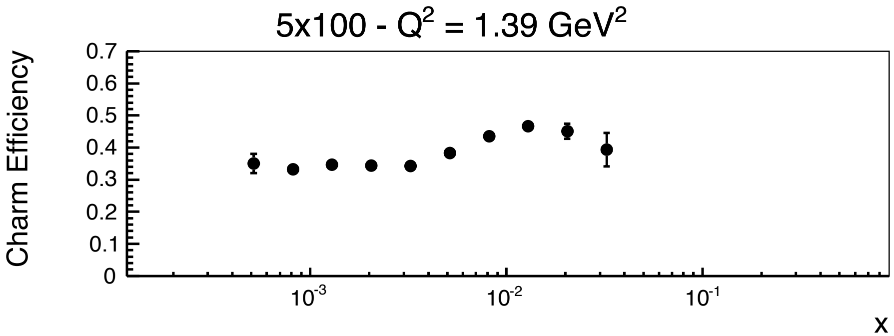
Charm election efficiency – kin. dependence

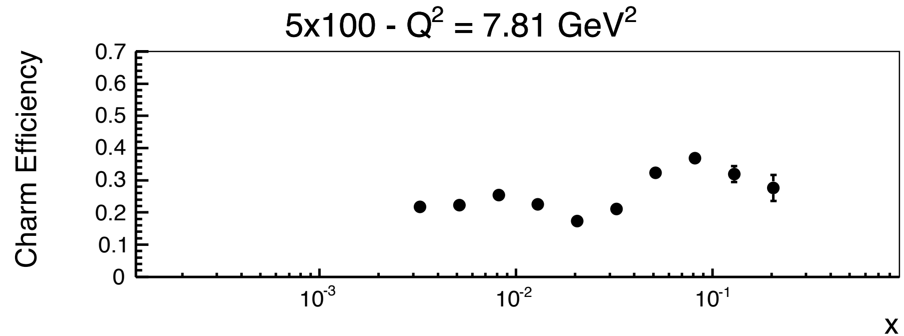
The errors on the efficiency are calculated with the binomial formula for correlated values

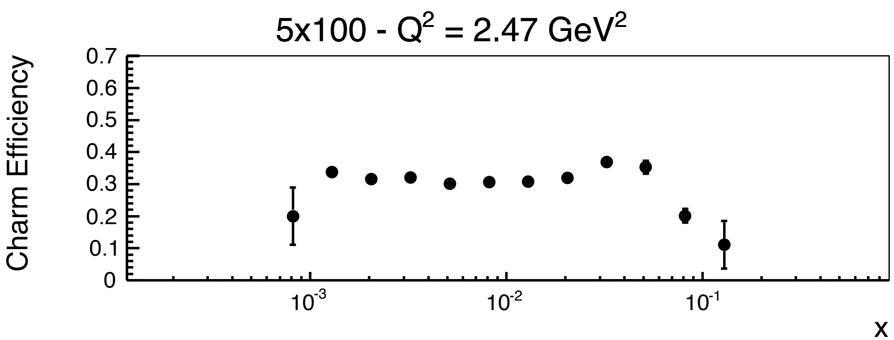


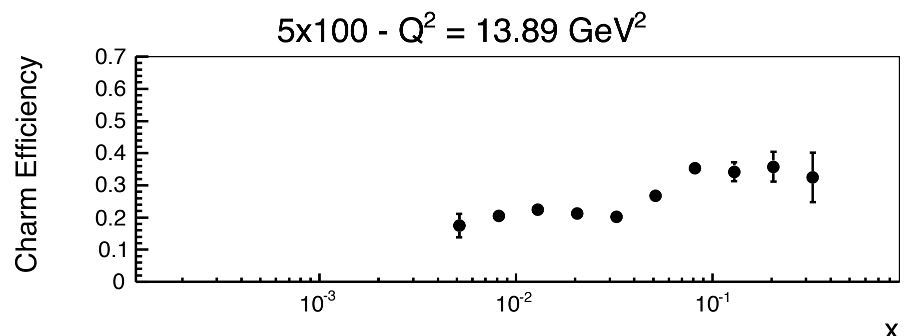
Charm election efficiency – kin. dependence

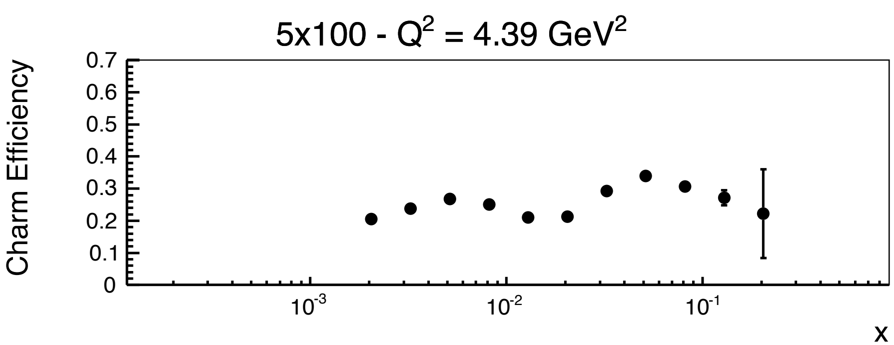
The errors on the efficiency are calculated with the binomial formula for correlated values

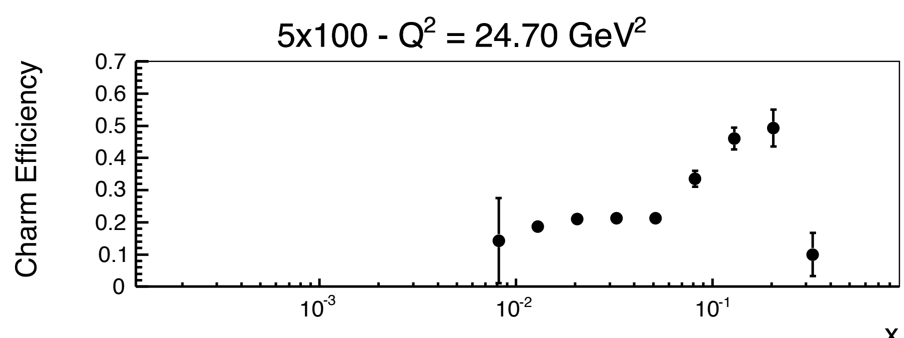












Charm election efficiency – kin. dependence

The errors on the efficiency are calculated with the binomial formula for correlated values